There are a vast number of chemical reactions that take place everyday. According to the Law of Conservation of Mass, the mass of the reactants prior to the reaction must equal to mass of the products after the reaction has occurred. We have discussed that in order for this to happen, the atoms cannot be destroyed nor can new atoms be created. The atoms simply rearrange themselves to form new substances.

A description of a chemical reaction is given in one of four ways: *a word equation, a skeleton equation, a balanced chemical equation, and a net ionic equation (this last one will be looked at later in the course).*

A *word equation* describes the reaction in sentence form. For example, when we heated magnesium in the presence of oxygen, a white ash-like substance was produced. This substance was magnesium oxide. The word equation for this reaction would be:

magnesium + oxygen → magnesium oxide

It would be read as follows – magnesium reacts with oxygen to produce magnesium oxide. This, however, gives limited information. It does not tell you the formulae of each of the substances nor does it tell you the masses required or produced.

A *skeleton equation* is the "bare-bones" of a balanced chemical equation. The 'words' are replaced by chemical formulae. The skeleton equation for the above reaction would be:

$$Mg + O_2 \rightarrow MgO$$

It is important that the correct formulae are written. Don't forget about the 7 elements that are diatomic molecules at room temperature and be sure to practice your nomenclature rules.

Inspection of the skeleton equation shows that the number of oxygen atoms prior to the reaction do not equal the number after the chemical reaction. This contradicts the Law of Conservation of Mass. The *balanced chemical equation* for the above reaction is shown below:

$$2\ Mg + O_2 \rightarrow 2\ MgO$$

Notice that, in balancing the equation, the formulae were not changed. All we did was introduce numbers (coefficients) in front of the symbols/formulas. How do we go about balancing a chemical equation once we have written the skeleton equation? The following method works for over 95% of all situations. We will deal with the other 5% later in the course.

STEP 1 Balance all atoms other than hydrogen or oxygen.

STEP 2 Balance the hydrogen atoms; make any adjustments to step 1 if necessary

STEP 3 Balance the oxygen atoms; make any adjustments if necessary

STEP 4 If you encounter difficulty in balancing the hydrogens, do step 3 before step 2.

STEP 5 Smile – its that easy!

The examples below are descriptions of various chemical reactions. For each example, write:

(A) the word equation
(B) the skeleton equation
(C) the balanced chemical equation

1. *Sodium hydroxide, used in many household drain cleaners, can be prepared by the reaction of calcium hydroxide with sodium carbonate. Calcium carbonate is also formed in this reaction.*

   Calcium hydroxide + sodium carbonate → sodium hydroxide + calcium carbonate
   $Ca(OH)_2 + Na_2CO_3 \rightarrow 2\ NaOH + CaCO_3$

2. *Lead(II) chloride reacts with sodium chromate to form a precipitate of lead(II) chromate and another substance. You should be able to infer what the other substance would be.*

   Lead(II) chloride + sodium chromate → lead(II) chromate + sodium chloride
   $PbCl_2 + Na_2CrO_4 \rightarrow PbCrO_4 + 2\ NaCl$

3. *You may have seen a thick haze commonly found over highly industrialized areas. One of the substances responsible for this haze is ammonium sulfate. This substance is formed from the reaction between ammonia and sulfuric acid, H_2SO_4.*

   Ammonia + sulfuric acid → ammonium sulfate
   $2\ NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

4. *Got an upset stomach due to acid indigestion? Magnesium hydroxide is often used to react with the acid in your stomach, hydrochloric acid or HCl. The products of the reaction are magnesium chloride and water.*

   Magnesium hydroxide + hydrochloric acid → magnesium chloride + water
   $Mg(OH)_2 + 2\ HCl \rightarrow MgCl_2 + 2\ H_2O$

5. *Carbon monoxide burns in oxygen to produce carbon dioxide.*

   $CO + \frac{1}{2}\ O_2 \rightarrow CO_2$ Or $2\ CO + O_2 \rightarrow 2\ CO_2$

6. *When potassium chlorate is strongly heated, it breaks down into potassium chloride and oxygen.*

   Potassium chlorate → potassium chloride + oxygen
   $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

7. *When calcium is added to water, calcium hydroxide is formed along with hydrogen gas.*

   Calcium + water → calcium hydroxide + hydrogen
   $Ca + 2\ H_2O \rightarrow Ca(OH)_2 + H_2$

8. *You have studied photosynthesis at some point in time. The process of photosynthesis produces glucose, $C_6H_{12}O_6$ and oxygen from the carbon dioxide and water.*

   Carbon dioxide + water → glucose + oxygen
   $6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$

9. *When you digest glucose, the glucose combines with oxygen in your cells to produce carbon dioxide and water. This process is known as cellular respiration. It is happening in your body as we speak.*

10. *Magnesium reacts with sulfuric acid creating magnesium sulfate and hydrogen gas.*

    Magnesium + sulfuric acid → magnesium sulfate + hydrogen
    $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

11. *Ammonia gas and hydrogen chloride gas react to form ammonium chloride, a white solid.*

    Ammonia + hydrogen chloride → ammonium chloride
    $NH_3 + HCl \rightarrow NH_4Cl$

12. *Sulfur dioxide is formed during the burning of coal that may contain sulfur. This gas responsible for acid rain. To reduce the amount of sulfur dioxide released into our atmosphere, sulfur dioxide is allowed to mix with calcium oxide. The product is calcium sulfite.*

    Sulfur dioxide + calcium oxide → calcium sulfite
    $SO_2 + CaO \rightarrow CaSO_3$

13. *If a bottle of hydrogen peroxide, H_2O_2, is allowed to sit at room temperature for an extended period of time, oxygen gas is slowly released and all that is left behind is water.*

    Hydrogen peroxide → oxygen + water
    $H_2O_2 \rightarrow \frac{1}{2} O_2 + H_2O$

14. *In some water treatment plants, yucky particles remain floating in the water. These particles must be removed before the water is released to the environment. How? Solutions of aluminum sulfate and calcium hydroxide are added to the water. A "sticky" precipitate of aluminum hydroxide forms. The particles stick to the aluminum hydroxide and sink to the bottom. Write the balanced chemical equation for the production of the aluminum hydroxide; there is another substance that is produced during this reaction. Once again, you should be able to infer what it is.*

    Aluminum sulfate + calcium hydroxide → aluminum hydroxide + calcium sulfate
    $Al_2(SO_4)_3 + 3\ Ca(OH)_2 \rightarrow 2\ Al(OH)_3 + 3\ CaSO_4$